CERTIFICATE OF FACSIMILE TRANSMISSION

I hereby certify that this paper (along with any paper referred to as being attached or enclosed) is being sent via facsimile to the RightFax facsimile number provided on the PTO website (571-273-8300) on the date shown below. This facsimile transmission includes a total of 37 pages, including 7 pages of exhibits and one page of credit card authorization.

Janet Farr
(Type or print name of person faxing paper)

Date: October 28, 2005

Janet Farr
(Signature of person faxing paper)

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES**

ATOTP0104US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of	
Nayan H. Joshi et al	Group Art Unit: 1762
Serial No.: 10/606,460	Examiner: M.B. Cleveland
Filed: June 26, 2003	Confirmation No. 3492

For: AQUEOUS ACIDIC IMMERSION PLATING SOLUTIONS AND METHODS FOR PLATING ON ALUMINUM AND ALUMINUM ALLOYS

APPEAL BRIEF

VIA FACSIMILE
M/S Appeal Briefs - Patents
Commissioner of Patents
P.O. Box 1450
Alexandria, VA 22313

Dear Sir:

This Appeal Brief is submitted in response to the final Office Action mailed 18 May 2005; Notice of Appeal and Request for Pre-Appeal Brief Review was filed 16 August 2005. The Notice of Panel Decision from Pre-Appeal Brief Review was mailed by USPTO on 30 September 2005, and provides a one-month period for submission of the Appeal Brief. Accordingly, Appellants' Appeal Brief is timely filed, with no extension of time.

Thomas W. Adams
Registration No. 35,047
RENNER, OTTO, BOISSELLE & SKLAR
1621 Euclid Ave., 19th Floor
Cleveland, Ohio 44115
(216) 621-1113 FAX (216) 621-6165

TABLE OF CONTENTS

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

ATOTP0104US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of	:	
Nayan H. Joshi et al	:	Group Art Unit: 1762
Serial No.: 10/606,460	:	Examiner: M.B. Cleveland
Filed: June 26, 2003	:	Confirmation No. 3492

For: AQUEOUS ACIDIC IMMERSION PLATING SOLUTIONS AND METHODS FOR PLATING ON ALUMINUM AND ALUMINUM ALLOYS

APPEAL BRIEF

M/S Appeal Brief - Patents
Commissioner of Patents
P.O. Box 1450
Alexandria, VA 22313

Dear Sir:

This Appeal Brief is submitted in the above-identified application in response to the final Office Action mailed 18 May 2005; Notice of Appeal and Request for Pre-Appeal Brief Review was filed 16 August 2005. The Notice of Panel Decision from Pre-Appeal Brief Review was mailed from USPTO on 30 September 2005.

I. REAL PARTY IN INTEREST

The real party in interest in this appeal is Atotech Deutschland GmbH, Erasmusstraße 20, Berlin, Germany D-10507. 37 C.F.R. §41.37(c)(1)(i).

II. RELATED APPEALS AND INTERFERENCES

Appellants are aware of no related appeals or interferences. 37 C.F.R. §41.37(c)(1)(ii).

11/02/2005 SSITHIB1 00000119 10606460
01 FC:1402 500.00 OP

III. STATUS OF CLAIMS

Claims 28-31, 36-42 and 50-72 are presently pending in the Application. Claims 1-27, 32-35 and 43-49 were cancelled previously. According to the Examiner, claims 53 and 64 have been withdrawn from consideration pursuant to an election of species requirement. Claims 28-31, 36-42 and 50-52, 54-63 and 65-72 stand finally rejected and are the subject of the present Appeal. Claims 53 and 64, indicated as "(Withdrawn)", are included with the claims under appeal, since if the generic claims are found allowable, these non-elected species claims would be allowable as well. The Appendix contains a copy of all of claims 28-31, 36-42 and 50-72, that is, all of the claims on appeal and the two withdrawn species claims. 37 C.F.R. §41.37(c)(1)(iii).

IV. STATUS OF AMENDMENT

Two amendments under 37 C.F.R. 1.116(a) were filed in this application. The first amendment under 37 C.F.R. 1.116(a), filed 11 July 2005, was met with an Advisory Action in which the claims submitted in the after-final reply would be entered, but the claim rejections were not withdrawn. These claims are the claims listed in the Appendix of this Appeal Brief. Subsequently, on 29 July 2005 Appellants filed a second amendment under 37 C.F.R. 1.116(a), to which the Examiner issued a second Advisory Action, refusing entry of the proposed amended claims in that proposed amendment. Thus, at the present time, there is no amendment pending. 37 C.F.R. §41.37(c)(1)(iv).

V. SUMMARY OF CLAIMED SUBJECT MATTER.

Appellants' summary of the claimed subject matter is set forth in the following, in compliance with 37 C.F.R. §41.37(c)(1)(v):

All of Appellants' presently pending claims relate to processes for depositing a zinc alloy protective coating on an aluminum or aluminum-based alloy substrates by immersion plating in an immersion plating solution including zinc ions, nickel and/or cobalt ions, fluoride ions and at least one inhibitor.

Appellants' invention, in one embodiment as described in claim 1, relates to a process for depositing a zinc alloy protective coating on aluminum or aluminum based alloy substrates which comprises

(A) immersing an aluminum or aluminum based alloy substrate in an aqueous acidic immersion plating solution (p. 13, lines 20-24) having a pH of from about 3.5 to about 6.5 (p. 5, line 12) and comprising zinc ions, nickel and/or cobalt ions, fluoride ions (p. 4, lines 2-3) and at least one inhibitor containing one or more nitrogen atoms, one or more sulfur atoms, or both sulfur and nitrogen atoms (p. 4, lines 6-8) provided the solution is free of cyanide ions (p. 4, line 3) for a period of time sufficient to deposit the desired coating, and

(B) removing the coated substrate from the immersion plating solution.

Appellants' invention, in one embodiment as described in claim 36, relates to a process for depositing a zinc alloy protective coating on aluminum or aluminum based alloy substrate which comprises

(A) immersing the substrate in an aqueous acidic immersion plating solution (p. 13, lines 20-24) having a pH of from about 4 to about 6 (p. 5, line 13) and comprising:

from about 10 to about 30 g/l of zinc ions (p. 5, line 23) ,

from about 20 to about 50 g/l of nickel and/or cobalt ions (p. 5, line 24-25),

from about 0.5 to about 10 g/l of fluoride ions (p. 5, line 26), and

from about 0.005 to about 0.05 g/l of an inhibitor (p. 9, line 20) containing one or more nitrogen atoms, one or more sulfur atoms, or both sulfur and nitrogen atoms (p. 4, lines 6-8) for a period of time sufficient to deposit the desired coating, and

(B) removing the coated substrate from the immersion plating solution.

Appellants' invention, in one embodiment as described in claim 40, relates to a process for depositing a metal coating on an aluminum or aluminum alloy substrate comprising

(A) applying an immersion zinc alloy protective coating on the substrate by immersing the substrate in an aqueous acidic immersion plating solution (p. 13, lines 20-24) having a pH of from about 3.5 to about 6.5 (p. 4, line 1-2) and comprising zinc ions, nickel and/or cobalt ions, fluoride ions (p. 4, line 2) and at least one inhibitor containing one or more nitrogen atoms, one or more sulfur atoms, or both sulfur and nitrogen atoms (p.

4, lines 6-8) provided the solution is free of cyanide ions (p. 4, lines 2-3) for a period of time sufficient to deposit the desired coating, and

(B) plating the zinc alloy coated substrate using an electroless or electrolytic metal plating solution (p. 14, lines 1-3).

Appellants' invention, in one embodiment as described in claim 60, relates to a process for depositing a zinc alloy protective coating on aluminum or aluminum based alloy substrate which comprises

(A) immersing the substrate in an aqueous acidic immersion plating solution (p. 13, lines 20-24) having a pH of from about 3.5 to about 6.5 (p. 4, line 1-2) and comprising:

from about 1 to about 150 g/l of zinc ions (p. 5, line 17),

from about 5 to about 250 g/l of nickel and/or cobalt ions (p. 5, lines 18-19),

from about 0.005 to about 100 g/l of fluoride ions (p. 19, line 22) provided the solution is free of cyanide ions (p. 4, lines 2-3), and

from about 0.005 to about 100 g/l of an inhibitor containing one or more nitrogen atoms, one or more sulfur atoms, or both sulfur and nitrogen atoms (p. 19, lines 25-27) for a period of time sufficient to deposit the desired coating, and

(B) removing the coated substrate from the immersion plating solution.

The present invention addresses the problem of replacement of conventional alkaline cyanide or non-cyanide alloying zincate for plating on aluminum and aluminum-based alloy substrates. The combination of solutions to these long-standing problems provided by the present invention as described in the pending claims and specification provides a number of advantages sought but not previously realized.

The present invention provides advantages in an immersion plating process such as avoiding the use of cyanide, and other complexing agents providing an immersion zinc nickel alloy layer on aluminum and aluminum alloys by displacement reaction without the problems encountered by the prior art, such as thin zinc alloy coats, complex immersion plating bath chemistry (which previously has been necessary to avoid or overcome problems resulting from, e.g., excessively high deposition of alloying metals as compared to zinc), and problems arising in treatment and disposal of spent immersion plating bath solutions. These issues are discussed in some detail at pp 1-3 of the present application.

Thus, the present invention provides significant improvements to prior art zinc alloy coatings applied to aluminum or aluminum-based alloy substrates.

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL.

Appellants' concise statement of each ground of rejection presented for review is set forth in the following, in compliance with 37 C.F.R. §41.37(c)(1)(vi):

APPELLANTS' CLAIMS 28, 36, 50-52, 54, 57-63, 65 and 68-72 STAND REJECTED UNDER 35 U.S.C. § 103(a) OVER U.S. PATENT 5,405,523 IN VIEW OF U.S. PATENT 4,888,218.

APPELLANTS' CLAIMS 29-31 AND 37-39 STAND REJECTED UNDER 35 U.S.C. § 103(a) OVER U.S. PATENT 5,405,523 IN VIEW OF U.S. PATENT 4,888,218, AND FURTHER IN VIEW OF U.S. PATENT 5,182,006.

APPELLANTS' CLAIM 40 STANDS REJECTED UNDER 35 U.S.C. § 103(a) OVER U.S. PATENT 5,405,523 IN VIEW OF U.S. PATENT 4,888,218 AND FURTHER IN VIEW OF GB PATENT 1,263,351.

APPELLANTS' CLAIMS 41 AND 42 STAND REJECTED UNDER 35 U.S.C. § 103(a) OVER U.S. PATENT 5,405,523 IN VIEW OF U.S. PATENT 4,888,218, FURTHER IN VIEW OF GB PATENT 1,263,351 AND FURTHER IN VIEW OF U.S. PATENT 5,182,006.

APPELLANTS' CLAIMS 55, 56, 66, 67 AND 72 STAND REJECTED UNDER 35 U.S.C. § 103(a) OVER U.S. PATENT 5,405,523 IN VIEW OF U.S. PATENT 4,888,218, AND FURTHER IN VIEW OF U.S. PATENT 5,182,006 AND FURTHER IN VIEW OF U.S. PATENT 4,356,067.

VII. ARGUMENT

In compliance with 37 C.F.R. §41.37(c)(1)(vii), Appellants' argument with respect to each ground of rejection presented for review set forth above in accordance with paragraph (c)(1)(vi) follows.

A. A Proper Understanding of the Technical Background Is Necessary for an Understanding and Review of Appellants' Claimed Invention.

As an initial matter, in order to understand and appreciate the inventive features of the present invention, it is important to understand the technology and in particular exactly what is "immersion plating". Appellants respectfully submit that in the present prosecution, the Examiner has lacked understanding of this term as it is known and used in the art. Appellants submit that the contended obviousness is based upon this lack of understanding, and that under a proper understanding of the technology, there can be no obviousness,

When a metal (M) is dissolved in a bath such as a plating bath, the metal has a positive charge (M^{+n}). In the process of being deposited on the substrate in the plating, electrons (e^-) are added to the metal and, as a result, the deposited metal has zero electrical charge (M^0). In electroplating, the electrons are obtained electrically from the rectifier, i.e., from an applied electrical current, which is the driving force for this type of plating.

There are two basic types of non-electrolytic or chemical plating: "electroless" plating and "immersion" plating.

In an "electroless" plating bath/process, the electrons are donated by a chemical dissolved in the bath, i.e., a reducing agent. The electrons donated by the reducing agent are added to the positively charged metal ions, thereby allowing or causing the metal to be deposited on the substrate with zero electrical charge. In electroless plating, the driving force is obtained from electrons donated by the reducing agent.

In an "immersion" plating bath/process, the electrons are supplied by the base metal, i.e., from the substrate itself, to which the plating is to be applied. Immersion plating depends on differences in the relative positions of the substrate and deposited metals on the electromotive force scale for the driving force. Thus, in immersion plating, the driving force is obtained from electrons released from the substrate undergoing plating. As the base metal donates electrons to the metal being plated, the base metal itself goes into solution, which is why this type of plating is sometimes called "replacement" or "displacement" plating, in addition to the more commonly used "immersion" plating.

Immersion plating is therefore self-limiting, since once the substrate surface is covered, it is difficult or not possible for further base metal to be removed from the surface and so difficult or not possible for further metal to be deposited from the immersion plating bath. Immersion plating can therefore result in deposition of a very thin, dense, non-porous coating in a very economical process.

The differences between these plating processes are well known and accepted in the metal finishing art. Appellants have submitted during prosecution and include herewith (in accordance with 37 C.F.R. §41.37(c)(1)(ix)) two documents available to those of ordinary skill in the art clearly demonstrating the art-recognized meaning of "immersion plating".

Although a plethora of examples exist in the U.S. patent literature clearly demonstrating the art-recognized meaning and use of "immersion plating" and the complete distinction of this term from both "electroplating" and "electroless plating", a single example suffices to show the art-recognized meaning of this term and, thereby, the clear error of the Examiner's contention. U.S. Patent No. 4,027,055 contains the following disclosure at column 1, lines 7-46 (in pertinent part):

> Methods are well-known to plate tin over metallic surfaces. The instant baths and methods are to be distinguished from the techniques based upon electrolytic deposition and electroless plating.
>
> Electrolytic plating is the production of adherent deposits of metals on conductive surfaces carried out by passage of electric current through an electroplating solution. The plating rate is determined by the current density impressed on the surface being plated.
>
> Electroless plating is a method of metal deposition without the assistance of an external supply of electrons but, requiring an agent present in the processing solution capable of reducing the ions to be deposited. The process is further characterized by the catalytic nature of the surface which enables the metal to be plated to any thickness. Typically, such solutions comprise a solvent, a supply of ions of the metal to be deposited, an agent capable of reducing the ions of the metal to be deposited, a complexing agent for the ions of the metal to be deposited, and a pH regulator.
>
> * * *
>
> Immersion plating or "contact plating" depends, however, upon a galvanic displacement reaction. The current instead of being furnished from an outside source, arises from reaction of the substrate itself and the metal being plated. Because of this, metal thickness has traditionally been limited

> to 10 to 50 millionths of an inch. As the immersion process depends upon the electrolytic action of the base metal, deposition stops as soon as the base metal is entirely covered forming a very thin deposit.

The foregoing discussion in U.S. Patent No. 4,027,055 clearly demonstrates the art-recognized differences, at least as long ago as 1977, between immersion plating and both electroless plating and electroplating. Without further belaboring the details of the distinctions between these processes, Appellants respectfully submit that the differences between electroplating and immersion plating, and the fact that the term "immersion plating" enjoys a well-recognized meaning in the art, is clear and indisputable based on the contents of this U.S. patent.

Appellants also previously submitted and include herewith the first three pages of "Overview of the Metal Finishing Industry", a publication available on the internet at the URL printed on each page of the publication. Beginning on page 2 of the Overview, there is a section headed "Electroplating" discussing electroplating methods. Immediately following, there is a section headed "Electroless Plating and Immersion Plating", discussing both of these techniques in turn. It is important to note that there are significant differences in the chemistry described for these three types of plating.

Without further belaboring the details of the distinctions between these processes, Appellants respectfully submit that the differences between electroplating and immersion plating, and the fact that the term "immersion plating" enjoys a well-recognized meaning in the art, is clear and indisputable based on the contents of this document.

Appellants also previously submitted and include herewith the first and fifth through seventh pages of "Appendix A Glossary", a publication available on the internet at the URL printed on each page of the publication. On page 5 of the Glossary, there is shown a definition of "electroless plating":

> The process of depositing metal from a water-based solution using chemical catalysts for the metal cation reduction process. In this process no external potential (electrical current) is applied.

On page 6 of the Glossary, there is shown a definition of "electroplating":

> The process of depositing metal from an aqueous solution using an external potential (electrical current) for the metal cation reduction process.

On page 7 of the Glossary, there is shown a definition of "immersion plating":

> A plating technique similar to electroless plating where a more electropositive metal is dissolved in an electrolyte and is plated onto the surface of a less electronegative metal workpiece. The term immersion plating is used where a deposit is obtained and the plating process then stops. This is distinguished from electroless plating where the deposition of the metal being plated continues to deposit as long as the workpiece remains in the solution.

Each of these has been marked with a box in the attached pages. Without belaboring the details of the distinctions between these processes, Appellants respectfully submit that the differences between electroplating and immersion plating, and the fact that the term "immersion plating" enjoys a well-recognized meaning in the art, is clear and indisputable based on the contents of this document.

As exemplified by the foregoing, it is well known to any person of ordinary skill in the metal finishing arts that electroplating and immersion plating are entirely different, that the chemistry is different, that the forces driving the deposition of metal upon a substrate are different, and that any ingredient useful in any one of these wholly separate arts may not be applicable to either of the others.

Accordingly, there is no basis, absent a showing of specifically supporting facts, for contending that any material used in an electroplating bath would be expected to be useful and thereby suggested for use in an immersion plating bath. Any such unsupported contention would be bare speculation. Thus, lacking any suggestion in the prior art, there can be no expectation that any particular material useful in one type of plating would be useful in another. Having no such suggestion or expectation, there can be no motivation for selecting specific materials from one for use in the other, and no *prima facie* obviousness for doing so. At the very best it might be "obvious to try" but "obvious to try" is not obviousness and cannot support a contention of *prima facie* obviousness.

B. Appellants' Claims 28-31, 36-42 and 50-52, 54-63 and 65-72 Would Not Have Been Obvious over U.S. Patent 5,405,523 in view of U.S. Patent 4,888,218, with or Without the Additional References.

Claims 28-31, 36-42, 50-52, 54-63 and 65-72 stand rejected as obvious over Eckles, U.S. Patent No. 5,405,523 and Suzuki et al., U.S. Patent No. 4,888,218, in view of each other, as the primary and secondary alternatively, together with various tertiary references as needed to meet all the limitations of Appellants' claims. Appellants respectfully traverse the rejections of these claims for at least the following reasons, and request the Board to reverse the Examiner's rejections of the claims over the asserted combinations of these references.

The Examiner contended, in rejecting Appellants' claims:

> '523 teaches a method for depositing a zinc alloy protective coating on metal substrates which comprises
>
> A) immersing a metal substrate in an aqueous acidic *immersion* plating solution having a pH of from about 3.5 to 6.2 (col. 2, lines 42-45) and comprising zinc ions (col. 2, lines 24-26), nickel and/or cobalt ions (col. 2, lines 26-28), negative ions such as chloride (col. 4, lines 36-44), and at least one inhibitor containing one or more nitrogen and/or sulfur atoms (col. 2, line 46-col. 3, line 8) for a period of time sufficient to deposit the desired coating, and
>
> B) removing the substrate because the substrate must inherently be removed from the bath for use. (Emphasis added.)

* * *

> '218 teaches a method for depositing a zinc *alloy* protective coating on aluminum
> substrates which comprises
>
> A) immersing an aluminum substrate in an aqueous acidic immersion plating solution having a pH of from about 4 to 6 (Abstract) and comprising zinc ions and fluoride ions (col. 5, lines 36-51) for a period of time sufficient to deposit the desired coating, and
>
> B) removing the substrate because the substrate must inherently be removed from the bath for use. (Emphasis added.)

The Examiner's basic contentions are clearly erroneous with respect to both references.

First, Eckles does not teach an *immersion* plating bath. In fact, Eckles teaches a zinc alloy *electroplating* bath comprising zinc ions, alloy metal ions of a metal of the first transition of the Periodic Table. The Examiner has identified nothing in Eckles that could even arguably suggest that the Eckles bath could function as an immersion plating bath or that any portion of the bath of Eckles could be used in an immersion plating bath. Furthermore, Eckles does not teach inhibitors. In fact, Eckles teaches brighteners which are distinct from the inhibitors disclosed and claimed by Appellants. Eckles teaches a brightening agent comprising a ureylene quaternary ammonium polymer, an iminoureylene quaternary ammonium polymer, or a thioureylene quaternary ammonium polymer. These are not disclosed or suggested by Eckles as inhibitors. Thus, both the Examiner's contention that Eckles teaches an immersion plating bath is clearly erroneous and the Examiner's contention that Eckles teaches an inhibitor is clearly erroneous. For this reason alone, the rejections are improper, unsupported and should be reversed.

Second, Suzuki et al. does not teach a method for depositing a zinc *alloy* coating, Suzuki et al. teaches only depositing a zinc coating, which is *not* a zinc alloy coating. Suzuki et al. teaches steps subsequent to the deposition of the zinc layer that may convert a portion of the interface of the zinc layer and the aluminum substrate into a zinc-aluminum mixture or alloy, but there is *no deposition of a zinc alloy* in Suzuki et al. Thus, the Examiner's contention that Suzuki et al. teaches a method for depositing a zinc alloy is *clearly erroneous*. An alloy formed by zinc and the substrate is not the same as an alloy of zinc deposited on the substrate. Any contention to the contrary is clearly erroneous.

Suzuki et al. teaches a process for coating an aluminum article with zinc by immersing the article in an aqueous bath prepared by dissolving solid zinc fluoride in water. Abstract. Suzuki et al. teaches only the use of zinc fluoride and does not teach or suggest the use of any other metal to deposit a zinc alloy. There is nothing in Suzuki et al. that would suggest that the use of fluoride might be applicable in or helpful to immersion plating of a zinc alloy. The Examiner has failed to identify anything that would motivate the selection of fluoride from Suzuki et al. for use in any other zinc immersion plating process, and certainly not in a zinc alloy immersion plating process such as that claimed.

From the other direction, there is nothing in either of Eckles or Suzuki et al. to suggest the extraction of a zinc alloy from the electroplating process of Eckles for use in the zinc-only immersion plating process of Suzuki et al. The Examiner has failed to identify anything that would motivate the selection of the alloying metals from Eckles for use in any zinc immersion plating process, and certainly not in a zinc alloy immersion plating process such as that claimed.

Based simply on the clearly erroneous "facts" stated by the Examiner, even if the teachings of Eckles and Suzuki et al. are combined, there still can be no *prima facie* case of obviousness. The only way all of the elements of the claimed invention can be assembled from the combined teachings of these references is by employing improper hindsight reconstruction of Appellants' claims. There is simply nothing whatsoever in either of these references that would have lead a person of ordinary skill in the art, at the time the invention was made (and without Appellants' disclosure as a guide), to have made the invention disclosed and claimed by Appellants.

Appellants respectfully submit that, throughout the prosecution, the Examiner has failed to state a legally correct *prima facie* case of obviousness. Specifically, although the Examiner identified some of the limitations of the claims in the cited references, the Examiner's position is based on the above-noted clearly erroneous views of the references. To wit, the Examiner contends that, because the Eckles reference teaches "immersing" the substrate in an electroplating bath, that Eckles teaches "an aqueous acidic immersion plating solution." This contention is clearly erroneous, because Eckles relates to electroplating, not to the art-recognized different immersion plating to which the present application and claims are directed.

Accordingly, the Examiner failed to identify all of the limitations, failed to provide any motivation for converting an electroplating bath and process to an immersion plating bath and process, and failed to show any reasonable expectation of success in so selecting and combining, in view of the teachings of the cited references as a whole. Thus, even if the references teach everything alleged by the Examiner, the references as a whole fail to teach or suggest Appellants' claimed invention as a whole, and thus there can be no *prima facie* obviousness. Accordingly, the teachings of the references as a whole fail to provide

the legally required basis for stating a *prima facie* case of obviousness. For these reasons, based on the details set forth below, the rejections of all of claims 28-31, 36-42, 50-52, 54-63 and 65-72 should be reversed.

In response to Appellants' arguments, in the Office Action mailed May 18, 2005, the Examiner contended:

> Applicant argues that Eckles does not teach an immersion plating bath because it teaches an electroplating bath. The argument is unconvincing because it is incorrect. Eckles teaches immersing the substrate in the electroplating bath. Therefore, it clearly meets the limitations of an "immersion plating bath" because it is an immersion bath and a plating bath.

In fact, it is the Examiner's argument that is technically incorrect and the Examiner's "facts" that are clearly erroneous, *not* Appellants'. As is well known and well established in the art as described above in (A), an immersion plating bath is not the same as an electroplating bath, and the fact that a substrate may be immersed in an electroplating bath does not convert the electroplating bath into an immersion plating bath. With this clearly erroneous contention as the factual basis for all of the obviousness rejections, the rejections are without basis and must be reversed. There can be no *prima facie* case of obviousness based on such clearly erroneous "facts".

Most importantly, there is nothing whatsoever in either Eckles or Suzuki to support, suggest or motivate, and the Examiner has wholly failed to identify any factual basis for the contention that it would be obvious, to extract the various elements of the teachings of these two references and combine the extracted elements in a way that would have rendered obvious the presently claimed invention. The Examiner has done little more than simply identify and then extract these elements from the references and then attempt to cobble them together to support the contention that it would have been obvious to do what is claimed.

"Determination of obviousness cannot be based on the hindsight combination of components selectively culled from the prior art to fit the parameters of the patented invention." *ATD Corp. v. Lydall, Inc.*, 48 USPQ2d 1321, 1329 (Fed. Cir. 1998). There *must be* a teaching or suggestion within the prior art, within the nature of the problem to

be solved, or within the general knowledge of a person of ordinary skill in the field of the invention, *to look to particular sources, to select particular elements, and to combine them as combined by the inventor.* See *Ruiz v. A.B. Chance Co.*, 234 F.3d 654, 665, 57 USPQ2d 1161, 1167 (Fed. Cir. 2000). Appellants respectfully submit that there is no such teaching or suggestion of the particulars or the combination in the present case.

C. The Examiner's Arguments in the Final Office Action and the Advisory Action Fail to Support the Contended Obviousness of Appellants' Claimed Invention.

In the Advisory action mailed 22 July, the Examiner contended:

> Applicants' remark that the term "electroplating" is completely distinct form "immersion plating" is found to be imprecise because electroplating may include immersion plating (see, e.g., Kowalski (U.S. Patent 3,928,147, col. 1, lines 27-39) and because displacement plating is a species of electroplating (See, e.g., Young, U.S. Patent 4,686,017, Abstract, and the classification schedule of class 205....

In the telephone interview of 28 July 2005, the Examiner admitted that previously he had not appreciated the differences between immersion plating and electroplating. Thus, the reason for the final rejection is due to the Examiner's admitted lack of knowledge of the art in the previous Office actions. But, rather than withdraw the admittedly factually incorrect and thereby unsupported rejections, the Examiner has maintained his position that the claimed "immersing an ... substrate in ... an immersion plating solution" was insufficient to distinguish the contended combination of references.

Thus, the Examiner continues to contend that electroplating *may* include immersion plating - that is, that immersion plating *may be* inherent in electroplating. This is clearly erroneous technically and is legally incorrect. The technical reasons are discussed above. It is legally incorrect since for any missing subject matter to be inherent in the disclosure from which it is missing, the missing disclosure *must*, not *may*, be present in the thing described, as is well known in the law. *Continental Can Co. v. Monsanto Co.*, 948 F.2d 1264, 1268, 20 USPQ2d 1746, 1749 (Fed. Cir. 1991). "Inherent anticipation requires that the missing descriptive material is `necessarily present,' not merely probably or possibly

present, in the prior art." *Trintec Indus., Inc. v. Top-U.S.A. Corp.*, 295 F.3d 1292, 1295, 63 USPQ2d 1597, 1599 (Fed. Cir. 2002).

Additionally, the Examiner continues to contend that immersion plating is a species of electroplating. This, too, is clearly erroneous as is shown below.

Immersion Plating Is Neither Inherent in Nor a Species of Electroplating

Both of the views stated by the Examiner in the July 28 interview and quoted above are factually incorrect and clearly erroneous. As such, they cannot form the basis for an obviousness rejection.

As discussed above and shown by the exhibits submitted by Appellants, the term "electrolytic plating" is a general term applicable to any kind of plating that involves the transfer of electrons as part of the plating process. Electrolytic plating is distinguished from, e.g., mechanical plating, in which metal is applied to a substrate by application of a mechanical force. In electrolytic plating, a transfer of electrons causes a metal ion in the plating bath to be reduced from its ionic state (M^{+n}) to the free metal state (M^0) through which metal M becomes deposited on the substrate. Thus, electrolytic plating includes all of electroplating, electroless plating and immersion plating. In *electroplating*, the transfer of electrons results from the applied (or impressed) electric current. In *electroless* plating, the transfer of electrons results from the electrons donated by a reducing agent in the plating bath. In *immersion* plating, the transfer of electrons results from the electrons freed by the oxidation of metal on the surface of the substrate that is being plated due to a natural difference in electrolytic potential between the two metals, using *neither* an impressed electrical current *nor* a reducing agent. Thus, the differences between these types of electrolytic plating are quite fundamental - different in each of chemistry, driving force and type of deposit.

The Examiner referred to U.S. Patent No. 4,686,017 to support his contention that "displacement plating is a species of electroplating". This statement is incorrect and results from a clearly erroneous reading of US '017. The correct use of the term "electrolytic plating" is reflected in US '017, in which, at col. 1, line 10-16, the following is stated:

> A variety of electrolytic methods are widely employed to deposit metals on or remove metals from conductive substrates for a variety of purposes.

> Electrolytic plating, including impressed current and sacrificial (immersion) plating, is used to produce decorative coatings ....

Clearly, the parenthetical in the Abstract of US '017 does not mean that immersion plating is a subset or species of electroplating. Rather, the parenthetical refers to the antecedent "electrolytic methods" or "electrolytic plating", and indicates that immersion plating is another electrolytic method, together with electroplating, not as a subset or species of electroplating. Electrolytic plating refers to plating by means of electron transfer. Clearly, the Examiner conflated the terms "electrolytic plating" and "electroplating". Appellants submit that no person of skill in the art would think that immersion plating is a species or subset of electroplating. The contention that this is so is clearly erroneous.

Immersion plating is *not* a species or subset of electroplating. It is a species or subset of the more general "electrolytic" plating and is recognized in the art as fully distinct from electroplating. This distinction is further supported by the Examiner's own example of the classification manual, in which 205/80 is entitled ELECTROLYTIC COATING, and which includes a variety of techniques including <u>both</u> displacement coating <u>and</u> various types of electroplating (the latter ignored by the Examiner in the Advisory action of 22 July 2005).

Regarding the suggestion that immersion plating might be an inherent property of electroplating baths, this is erroneous for similar reasons. The teachings of U.S. Patent No. 3,928,147 (also cited by the Examiner in the Advisory action of 22 July 2005) recognize that under some conditions, i.e., with some chemistries, copper is capable of immersion plating on zinc, and that this is to be avoided. See, for example, col. 1, lines 22-26, which teaches that chemical deposition, i.e., immersion plating, of copper on zinc is to be avoided because the deposited copper film has poor adhesion and uniformity. US '147 goes on to teach that by adjusting the chemistry, the desired electroplating can be obtained.

US '147 also indicates in the table at col. 2 that zinc is capable of immersion plating on aluminum. However, this is not Appellants' claimed invention, which includes a number of other features, most notably immersion plating of a zinc *alloy*, at a specified pH, with both fluoride ions and an inhibitor present in the immersion plating bath. The fact that

some metals can be applied by both electroplating and immersion plating does not equate the two, nor does it mean that one is inherent in the other, nor does it necessarily extend to alloys. (In this regard, Appellants note that "Inherent anticipation requires that the missing descriptive material is 'necessarily present,' not merely probably or possibly present, in the prior art." *Trintec Indus., Inc. v. Top-U.S.A. Corp.*, 295 F.3d 1292, 1295, 63 USPQ2d 1597, 1599 (Fed. Cir. 2002).

Finally, in the Advisory action of 22 July 2005, at page 3, the Examiner contended:

> The solution suggested by Eckles and Suzuki either must be capable of such use [immersion plating] because they contain the same components as in Applicant's claims or else such ability results from essential features which are not present in the claims.

This contention begs the question of whence comes an immersion plating solution having the claimed features. There has been no showing of any suggestion or motivation to selectively extract specific elements from these two references for combination as contended by the Examiner but in actuality only specifically existing in Appellants' claims. Here again, the Examiner simply overlooks and omits the necessary showing of a suggestion or motivation to combine. Appellants submit that the differences between Eckles and Suzuki are such that there can be no such suggestion in either of these references, and the Examiner has failed throughout the prosecution of this application to show any such suggestion or motivation, having arrived at his obviousness rejection by improper use of hindsight reconstruction based only on Appellants' disclosure.

For all of the foregoing reasons, Appellants respectfully submit that the Examiner's rejections of all of Appellants' pending claims must be reversed, since the rejections are baseless in both fact and law.

D. The Rejections of the Dependent Claims Are Baseless and Should Be Reversed.

The dependent claims provide further distinctions over the prior art, and the Examiner has failed to state a *prima facie* case of obviousness with respect to the dependent claims for the following additional reasons.

The Examiner rejected claims 50, 51, 52, 54, 59, 61-63, 65, 69-71 in conclusory fashion, failing even to identify from which patent he extracted the disclosures alleged to meet the limitations of these claims. Thus, the Examiner has wholly failed to state any legally correct *prima facie* case of obviousness of these claims, and the rejections thereof should be reversed for this additional reason.

Claim 40 stands rejected as obvious over the basic combination of Eckles and Suzuki, and further in view of GB Patent No. 1 263 351. The Examiner contends that GB 351 discloses use of zinc alloy coatings before further metal plating by electrolytic deposition. The Examiner wholly ignores the fact that in GB 351 the zinc alloy coating is itself applied by *electroplating*, not by any immersion process. As noted in detail above, these processes are distinct and anything useful in one is not necessarily useful in the other. Thus, the Examiner has again failed to identify all of the features of the claimed invention with respect to the rejection of claim 40.

Thus, the Examiner has wholly failed to state any legally correct *prima facie* case of obviousness of this claim, and the rejection of claim 40 should be reversed for this additional reason. Furthermore, since claims 41 and 42 depend from claim 40, the rejection of these claims should be reversed as well.

Claims 55, 56, 66, 67 and 72 stand rejected as obvious over the basic combination of Eckles and Suzuki, and further in view of McCoy, U.S. Patent No. 4,356,067. The Examiner contends that '067 teaches the use of 2-mercaptobenzimidiazole as a brightener. Unfortunately, the Examiner again failed to note that McCoy relates to *electroplating*, not to immersion plating, that McCoy teaches highly alkaline conditions, not acidic conditions, and that McCoy relates to electroplating copper-zinc alloys, not to alloys of zinc and nickel and/or cobalt, all as claimed by Appellants' claims. All of these differences mean that the teachings of McCoy have little or no applicability to the present invention. Thus, the fact

that McCoy may use a particular brightener in a wholly different system is irrelevant to and cannot possibly support the contended obviousness of these claims. Thus, the Examiner has again failed to identify all of the features of the claimed invention with respect to the rejection of claims 55, 56, 66, 67 and 72, and the rejections of these claims should be reversed for this additional reason.

VIII. CONCLUSION

For all these reasons, the rejection of Appellants' claims 28-31, 36-42, 50-52, 54-63 and 65-72 under 35 U.S.C. §103(a) should be reversed.

Appellants respectfully request reversal of the Examiner's rejections of Appellants' claimed invention.

Appellants respectfully submit that all of the pending claims are in condition for allowance, and respectfully request notice to such effect from the Examiner and/or the Board.

In the event issues remain in the prosecution of this application, Appellants request that the Examiner telephone the undersigned attorney to expedite further consideration and/or allowance of the claims of this application. Should a Petition for Extension of Time be necessary for the present Appeal Brief to be timely filed (or if such a petition has been made and an additional extension is necessary) petition therefor is hereby made and, if any additional fees are required for the filing of this paper, the Commissioner is authorized to charge those fees to Deposit Account #18-0988, Docket No. ATOTP0104US.

Respectfully submitted,

RENNER, OTTO, BOISSELLE & SKLAR

Thomas W. Adams

Date: October 28, 2005

Thomas W. Adams, Reg. No. 35,047

1621 Euclid Ave., 19th Floor
Cleveland, Ohio 44115
(216) 621-1113

APPENDICES:

CLAIMS SUBJECT TO APPEAL

In accordance with 37 C.F.R. §41.37(c)(1)(viii), the following claims are the subject of the present appeal:

1.-27. (Cancelled)

28. A process for depositing a zinc alloy protective coating on aluminum or aluminum based alloy substrates which comprises

(A) immersing an aluminum or aluminum based alloy substrate in an aqueous acidic immersion plating solution having a pH of from about 3.5 to about 6.5 and comprising zinc ions, nickel and/or cobalt ions, fluoride ions and at least one inhibitor containing one or more nitrogen atoms, one or more sulfur atoms, or both sulfur and nitrogen atoms provided the solution is free of cyanide ions for a period of time sufficient to deposit the desired coating, and

(B) removing the coated substrate from the immersion plating solution.

29. The process of claim 28 wherein the surface of the aluminum or aluminum based alloy is cleaned, etched and desmutted prior to immersion in the immersion plating solution.

30. The process of claim 29 wherein the cleaning is performed with an alkaline, acidic, or solvent cleaner, and the etching is performed with an alkaline or acid etching solution.

31. The process of claim 29 wherein the aluminum or aluminum based alloy is rinsed with water after each of the cleaning, etching, desmutting, and immersion plating steps.

32.-35. (Cancelled)

36. A process for depositing a zinc alloy protective coating on aluminum or aluminum based alloy substrate which comprises

(A) immersing the substrate in an aqueous acidic immersion plating solution having a pH of from about 4 to about 6 and comprising:

from about 10 to about 30 g/l of zinc ions,

from about 20 to about 50 g/l of nickel and/or cobalt ions,

from about 0.5 to about 10 g/l of fluoride ions, and

from about 0.005 to about 0.05 g/l of an inhibitor containing one or more nitrogen atoms, one or more sulfur atoms, or both sulfur and nitrogen atoms for a period of time sufficient to deposit the desired coating, and

(B) removing the coated substrate from the immersion plating solution.

37. The process of claim 36 wherein the surface of the substrate is cleaned, etched and desmutted prior to immersion in the immersion plating solution.

38. The process of claim 37 wherein the cleaning is performed with an alkaline, acidic, or solvent cleaner, and the etching is performed with alkaline or acid etching solution.

39. The process of claim 37 wherein the substrate is rinsed with water after each of the cleaning, etching, desmutting, immersion plating steps.

40. A process for depositing a metal coating on an aluminum or aluminum alloy substrate comprising

(A) applying an immersion zinc alloy protective coating on the substrate by immersing the substrate in an aqueous acidic immersion plating solution having a pH of from about 3.5 to about 6.5 and comprising zinc ions, nickel and/or cobalt ions, fluoride ions and at least one inhibitor containing one or more nitrogen atoms, one or more sulfur atoms, or both sulfur and nitrogen atoms provided the solution is free of cyanide ions for a period of time sufficient to deposit the desired coating, and

(B) plating the zinc alloy coated substrate using an electroless or electrolytic metal plating solution.

41. The process of claim 40 wherein the surface of the substrate is subjected to cleaning, acid etching and desmutting, prior to immersion in the immersion plating solution.

42. The process of claim 41 wherein the cleaning is performed with an alkaline, acidic, or solvent cleaner, and the etching is performed with alkaline or acid etching solution.

43-49. (Cancelled)

50. The process of claim 28 wherein the plating solution also contains one or more metal complexing agents.

51. The process of claim 28 wherein the plating solution also contains one or more additional metal ions selected from copper ions, iron ions, manganese ions, magnesium ions and zirconium ions.

52. The process of claim 28 wherein the inhibitor is selected from nitrogen-containing disulfides; alkali metal thiocyanates; thiocarbamates; nitrogen-containing heterocyclic compounds; mercapto substituted nitrogen-containing heterocyclic compounds; thioacids; thioalcohols; compounds characterized by the formula

$$R_2N{-}C(S)Y \qquad \text{I}$$

wherein each R is independently hydrogen or an alkyl, alkenyl, or aryl group, and Y is XR^1, NR_2 or $N(H)NR_2$; wherein X is O or S and R^1 is hydrogen or an alkali metal; and mixtures thereof.

53. (Withdrawn) The process of claim 28 wherein the inhibitor is a thiourea compound represented by the formula:

$$[R_2N]_2CS \qquad II$$

wherein each R is independently hydrogen or an alkyl, alkenyl or aryl group.

54. The process of claim 28 wherein the inhibitor is at least one nitrogen containing heterocyclic compound or mercapto substituted nitrogen containing heterocyclic compound, or mixtures thereof.

55. The process of claim 54 wherein the heterocyclic compound is selected from pyrroles, imidazoles, benzimidazoles, pyrazoles, triazoles, pyridines, piperazines, pyrazines, piperidines, pyrimidines, thiazoles, thiazolines, thiazolidines, rhodamines, and morpholines.

56. The process of claim 54 wherein the inhibitor is a mercapto substituted nitrogen containing heterocyclic compound.

57. The process of claim 28 wherein the plating solution contains
from about 1 to about 150 g/l of zinc ions, and
from about 5 to about 250 g/l of nickel and/or cobalt ions.

58. The process of claim 54 wherein the plating solution contains from about 0.0005 to about 5 g/l of the inhibitor.

59. The process of claim 28 wherein the plating solution is free of aliphatic amines and aliphatic hydroxylamines.

60. A process for depositing a zinc alloy protective coating on aluminum or aluminum based alloy substrate which comprises

(A) immersing the substrate In an aqueous acidic immersion plating solution having a pH of from about 3.5 to about 6.5 and comprising:

from about 1 to about 150 g/l of zinc ions,

from about 5 to about 250 g/l of nickel and/or cobalt ions,

from about 0.005 to about 100 g/l of fluoride ions provided the solution is free of cyanide ions, and

from about 0.005 to about 100 g/l of an inhibitor containing one or more nitrogen atoms, one or more sulfur atoms, or both sulfur and nitrogen atoms for a period of time sufficient to deposit the desired coating, and

(B) removing the coated substrate from the immersion plating solution.

61. The process of claim 60 wherein the plating solution also contains at least one metal complexing agent.

62. The process of claim 61 wherein the metal complexing agent is selected from an acetate, citrate, glycollate, lactate, maleate, pyrophosphate, tartrate, gluconate, or glucoheptonate, and mixtures thereof.

63. The process of claim 60 wherein the inhibitor is selected from nitrogen-containing disulfides, alkali metal thiocyanates, alkali metal thiocarbamates, nitrogen-containing heterocyclic compounds, mercapto substituted nitrogen containing heterocyclic compounds, thioacids, thioalcohols, compounds characterized by the formula

$$R_2N\text{—}C(S)Y \qquad \text{I}$$

wherein each R is independently hydrogen or an alkyl, alkenyl, or aryl group, and Y is XR^1, NR_2 or $N(H)NR_2$, wherein X is O or S and R^1 is hydrogen or an alkali metal and mixtures thereof.

64. (Withdrawn) The process of claim 60 wherein the inhibitor is a thiourea compound represented by the formula:

$$[R_2N]_2CS \qquad \text{II}$$

wherein each R is independently hydrogen or an alkyl, alkenyl or aryl group.

65. The process of claim 60 wherein the inhibitor is at least one nitrogen containing heterocyclic compound or a mercapto substituted nitrogen containing heterocyclic compound or mixtures thereof.

66. The process of claim 65 wherein the heterocyclic compound is selected from pyrroles, imidazoles, pyrazoles, triazoles, tetrazoles, thiazoles. thiazolines, thiazolidines, pyridines, piperazines, pyrazines, piperidines, pyrimidines, and morpholines.

67. The process of claim 60 wherein the inhibitor is a mercapto substituted nitrogen containing heterocyclic compound.

68. The process of claim 60 wherein the plating solution has a pH of from about 4 to about 6.

69. The process of claim 60 wherein the plating solution also contains one or more metal ions selected from copper ions, iron ions, manganese ions, magnesium ions and zirconium ions.

70. The process of claim 60 wherein the plating solution is free of aliphatic amines and aliphatic hydroxylamines.

71. The process of claim 36 wherein the plating solution also contains from about 1 to about 250 g/l of at least one metal complexing agent.

72. The process of claim 36 wherein the inhibitor is a mercapto substituted nitrogen containing heterocyclic compound.

EVIDENCE

In accordance with 37 C.F.R. §41.37(c)(1)(ix), Appellants note that in the present application the following evidence has been submitted and is relied upon by Appellants in the appeal. Evidence consisting of copies of the following publications was submitted by Appellants in the Reply to Office Action Mailed 18 May 2005, which was filed by Appellants on 11 July 2005 and was entered upon filing of Appellants' Notice of Appeal, as indicated by the Examiner in the Advisory Action mailed 22 July 2005.

Metal Finishing Industry, Overview of the Metal Finishing Industry, 3 pp., obtained from:
http://www.wmrc.uiuc.edu/main_sections/info_services/library_docs/manuals/finishing/overview.htm

Metal Finishing Industry, Appendix A Glossary, 4 pp., obtained from:
http://www.wmrc.uiuc.edu/main_sections/info_services/library_docs/manuals/finishing/appxa1.htm

RELATED PROCEEDINGS

In accordance with 37 C.F.R. §41.37(c)(1)(x), Appellants note that in the present application there are no related proceedings; therefore there is no documentation relating to such proceedings.

B:\Adams-Tom\Client Files\ATOT\ATOT104\ATOT104.appBRF.wpd

Metal Finishing Industry

Table of Contents Overview Regulatory Planning P2 Programs Common P2 Practices Pre-Finishing Operations P2 in Plating P2 in Rinsing Alternative Methods of Metal Deposition Facility Design

Overview of the Metal Finishing Industry

These days everyone doing pollution prevention assistance seems interested in helping the metal finishing industry; ever wonder why? Metal finishing, when taken as a whole, is one of the largest users of many toxics chemicals in the country. Electroplating alone is the second largest end user of nickel and nickel compounds, and the third largest end user of cadmium and cadmium compounds. Electroplating also accounts for a substantial amount of chromium use in the United States. In other words, this industry is responsible for managing large amounts of hazardous materials (Davis 1994).

Many industries use metal finishing in their manufacturing processes including automotive, electronics, aerospace, hardware, jewelry, heavy equipment, appliances, tires, and telecommunications. Figure 1 shows the percent of markets served by metal finishers in 1992.

Figure 1. Markets Served by Metal Finishers—Percent of 1992 Market (EPA 1995a)

Why is metal finishing so prevalent? Without metal finishing, products made from metals would last only a fraction of their present lifespan because of corrosion and wear. Finishing is also used to enhance electrical properties, to form and shape components, and to enhance the bonding of adhesives or organic coatings. Sometimes the finishes are used to meet consumer demand for a decorative appearance.

Overall, metal finishing alters the surface of metal products to enhance:

- Corrosion resistance
- Wear resistance
- Electrical conductivity
- Electrical resistance
- Reflectivity and appearance (e.g., brightness or color)
- Torque tolerance
- Solderability
- Tarnish resistance
- Chemical resistance
- Ability to bond to rubber (e.g., vulcanizing)
- Hardness

Metal finishers use a variety of materials and processes to clean, etch, and plate metallic and non-metallic surfaces to create a workpiece that has the desired surface characteristics. Electrolytic plating, electroless plating, and chemical and electrochemical conversion processes are typically used in the industry. Typical supporting processes can include degreasing, cleaning, pickling, etching, and/or polishing.

Some of the materials used in metal finishing are solvents and surfactants for cleaning, acids and bases for etching, and solutions of metal salts for plating the finish onto the substrate. Figure 2 presents an overview of the fabricated metal products manufacturing process and shows the types of emissions and wastes that are generated during production.

Figure 2. Overview of the Metal Fabricating Process (EPA 1995a)

Types of Shops

The electroplating, plating, polishing, anodizing, and coloring industry is classified under the Standard Industrial Classification (SIC) code 3471 and includes establishments primarily engaged in all types of metal finishing. Companies that both manufacture and finish products are classified according to products they make. Nonetheless, they are still considered part of the metal finishing industry.

Firms that rely on one customer or that conduct metal finishing as part of a larger operation are referred to as captive shops. These companies tend to have larger operations than job shops. Independent facilities, often referred to as job shops, rely on a variety of customers and coat a variety of workpieces and substrates. In general, job shops tend to be small and independently owned. Enough similarities exist between the job and captive shops that they are essentially considered part of one industry. The job and captive shops use the same types of processes and fall within the same regulatory framework (EPA 1995a).

However, the barriers they face in deciding upon and implementing new technologies reflect the differences in their environmental performance and in the corporate capabilities of the two segments. Captive operations, which are more specialized, can focus their operations because they often work on a limited number of products and/or use a limited number of processes. Job shops, on the other hand, tend to be less focused in their operations because they can have many customers often with different requirements. In general, captive shops tend to have greater access to financial and organizational resources and, as a result, tend to be more proactive in their approach to environmental management. However, this is not always the case. The vastly different cultures in these shops greatly affects their perceived ability to implement pollution prevention (EPA 1994).

Job shops and captive shops do not ordinarily compete against each other because captive finishers seldom seek contract work. However, captive facilities might use job shops as subcontractors to perform tasks that their operations are unable to or that they choose not to do. As a nationwide trend, many manufacturers are choosing to eliminate or reduce metal finishing operations from their facilities because it is not of strategic importance for their long-term success. In some of these cases, the larger firms have shifted their plating activities to job shops (EPA 1995a).

Types of Metal Finishing Processes

Metal finishing comprises a broad range of processes that are practiced by most industries which manufacture metal parts. Typically, manufacturers perform the finishing after a metal part has been formed. Finishing can be any operation that alters the surface of a workpiece to achieve a certain property. Common metal finishes include paint, lacquer, ceramic coatings, and other surface treatments. This manual mainly addresses the plating and surface treatment processes.

The metal finishing industry generally categorizes plating operations as electroplating and electroless plating. Surface treatments consist of chemical and electrochemical conversion, case hardening, metallic coating, and chemical coating. The following sections briefly describe the major plating and surface treatment processes in order to provide a context for the more in-depth information in the chapters that follow.

Electroplating

Electroplating is achieved by passing an electric current through a solution containing dissolved metal ions and the metal object to be plated. The metal object serves as the cathode in an electrochemical cell, attracting ions from the solution. Ferrous and non-ferrous metal objects are plated with a variety of metals including aluminum, brass, bronze, cadmium, copper, chromium, gold, iron, lead, nickel, platinum, silver, tin, and zinc. The process is regulated by controlling a variety of parameters including voltage and amperage, temperature, residence times, and purity of bath solutions. Plating baths are almost always aqueous solutions, therefore, only those metals that can be reduced in aqueous solutions of their salts can be electrodeposited. The only major exception to this principle is aluminum, which can be plated from organic electrolytes (EPA 1995a).

Plating operations are typically batch operations in which metal objects are dipped into a series of baths containing various reagents for achieving the required surface characteristics. Operators can either carry the workpieces on racks or in barrels. Operators mount workpieces on racks that carry the part from bath to bath. Barrels rotate in the

plating solution and hold smaller parts (Ford 1994).

The sequence of unit operations in an electroplating process is similar in both rack and barrel plating operations. A typical plating sequence involves various phases of cleaning, rinsing, stripping, and plating. Electroless plating uses similar steps but involves the deposition of metal on metallic or non-metallic surfaces without the use of external electrical energy (EPA 1995a).

Electroless Plating and Immersion Plating

Electroless plating is the chemical deposition of a metal coating onto an object using chemical reactions rather than electricity. The basic ingredients in an electroless plating solution are a source metal (usually a salt), a reducer, a complexing agent to hold the metal in solution, and various buffers and other chemicals designed to maintain bath stability and increase bath life. Copper and nickel electroless plating commonly are used for printed circuit boards (Freeman 1995).

Immersion plating is a similar process in that it uses a chemical reaction to apply the coating. However, the difference is that the reaction is caused by the metal substrate rather than by mixing two chemicals into the plating bath. This process produces a thin metal deposit by chemical displacement, commonly zinc or silver. Immersion plating baths are usually formulations of metal salts, alkalis, and complexing agents (e.g., lactic, glycolic, or malic acids salts). Electroless plating and immersion plating commonly generate more waste than other plating techniques, but individual facilities vary significantly in efficiency (Freeman 1995).

Chemical and Electrochemical Conversion

Chemical and electrical conversion treatments deposit a protective and/or decorative coating on a metal surface. Chemical and electrochemical conversion processes include phosphating, chromating, anodizing, passivation, and metal coloring. Phosphating prepares the surface for further treatment. In some instances, this process precedes painting. Chromating uses hexavalent chromium in a certain pH range to deposit a protective film on metal surfaces. Anodizing is an immersion process in which the workpiece is placed in a solution (usually containing metal salts or acids) where a reaction occurs to form an insoluble metal oxide. The reaction continues and forms a thin, non-porous layer that provides good corrosion resistance. Sometimes this process is used as a pretreatment for painting. Passivating also involves the immersion of the workpiece into an acid solution, usually nitric acid or nitric acid with sodium dichromate. The passivating process is used to prevent corrosion and extend the life of the product. Metal coloring involves chemically treating the workpiece to impart a decorative finish (EPA 1995a).

Other Surface Finishing Technologies

Other commonly used finishing technologies that do not fall into the plating or chemical and electrochemical conversion processes include cladding, case hardening, dip/galvanizing, electropolishing, and vapor deposition. The following sections provide brief overviews of these different processes.

Cladding

Cladding is a mechanical process in which the metal coating is metallurgically bonded to the workpiece surface by combining heat and pressure. An example of cladding is a quarter. The copper inside is heated and pressed between two sheets of molten nickel alloy, bonding the materials. Cladding is used to deposit a thicker coating than electroplating, and requires less preparation and emits less waste. However, equipment costs are higher than electroplating (Freeman 1995).

Case Hardening

Case hardening is a metallurgical process that modifies the surface of a metal. The process produces a hard surface (case) over a metal core that remains relatively soft. The case is wear-resistant and durable, while the core is left strong and pliable. In case hardening, a metal is heated and molded and then the temperature is quickly dropped to quench the workpiece. An example of a material made with case hardening is the Samurai sword. The hardened

Metal Finishing Industry

Appendix A Glossary

abrasive blasting = A method to remove brittle materials such as millscale oxide, remains of paint etc. More generally referred to as grit blasting.

acid = Chemical substance whose water solutions exhibit a pH less than 7.

acid descaling = An alternative name for "pickling" a process using acid to dissolve oxide and scale.

activation = Process of removing last trace of oxide on a metal surface and a thin layer of the metal itself to ensure that the metal surface to be plated is electrochemically active. (see "etching")

addition agent = Material used to modify the character of the deposit, usually used only in small amounts.

alkaline descaling= A chemical process for removing scale. A typical descaling solution uses caustic soda with additives such as detergents and chelating agents.

alloying = The addition of one metal to another metal or non-metal or combinations of metals. For instance, steel is an alloy of carbon and iron. Other metals are added to steels to impart specific characteristics like strength or corrosion resistance.

"Alochrom" = A proprietary process applied to aluminum and its alloys to improve corrosion resistance or to prepare surfaces for painting. Treatment produces an adherent aluminum oxide with some absorbed chromate.

amalgamating = Process in which alloys are formed with mercury such as gold, silver, iron, copper and aluminum. Due to the toxicity of mercury, use of the technique is declining.

amorphous = Structure that is non-crystalline or without a regular structure.

ampere = The current that will deposit silver at the rate of 0.0011180 grams per second. Current flowing at the rate of one coulomb.

annealing = A heat treatment process which may be applied to all metals to soften them.

anode = The positive electrode in electrolysis, at which negative and positive ions are discharged, positive ions are formed, or other oxidizing reactions occur.

anodic coating = A protective, decorative, or functional coating formed by conversion of the surface of a metal in an electrolytic oxidation process.

anodic etching = A form of electrolytic etching where the workpiece is being etched is anodic in the electrolytic circuit (in electroplating, the workpiece is the cathode).

anodizing = A process generally applied to aluminum and its alloys to produce an adherent oxide film to impart corrosion resistance or surface hardness.

anolyte = The portion of an electrolyte in the vicinity of the anode. In a divided cell, the portion of the electrolyte that is on the anode side of the diaphragm.

aquablast = A surface cleaning process which can be applied to any material where an abrasive material is suspended in water. The resulting slurry is pressurized and ejected through a nozzle. Since higher pressures can be

instances it is inconspicuous. Various methods are used for this process including blasting, pickling, acid or alkaline sodium hydride treatments, and polishing.

die-casting = A method of casting in which molten metal is poured, sometimes under pressure, into a mold or die. The die is made of metal and immediately after solidification of the casting the die opens and the casting is ejected.

diffusion coating = An alloy coating produced by applying heat to one or more metal coatings deposited on a metal.

distribution = Refers to the uniformity of the metal deposited from a plating process.

dragin = The water or solution that adheres to workpieces introduced into a bath.

dragout = The solution that adheres to a workpiece removed from a bath.

dry blasting = A general name given to any form of blasting where the abrasive agent is not carried in water.

dry-form lubrication = A form of painting applied to steel surfaces of workpieces subject to light wear or abrasion. It generally uses colloidal or molybdenum disulfide carried in a phenolic resin.

ductility = Refers to the flexibility of an electroplated deposit; this parameter is critical when bending and forming operations occur after plating.

dummy (dummy cathode) = A cathode in a plating solution that is not to be used after plating; often used for removal or decomposition of impurities.

effluent = Any gas or liquid emerging from a pipe or similar outlet; usually refers to waste products from chemical or industrial plants as stack gases or liquid mixtures.

electrocleaning = An electrochemical cleaning process by which a workpiece is first made the cathode in an electrolytic cell. When current is applied, the generation of hydrogen gas from the electrolysis of water at the surface of the workpiece results in a highly efficient scrubbing action. Following initial treatment as a cathode the circuit is reversed so that the workpiece is the anode. Oxygen gas, which is generated at the surface produces a final cleaning action.

electrode = A conductor through which current enters or leaves an electrolytic cell at which there is a change from conduction by electrons to conduction by charged particles of matter or vice versa.

electrode potential = The difference in potential between an electrode and the immediately adjacent electrolyte.

electroforming = A specific form of electroplating used where intricate shapes and relatively thin metal deposits are required. Molds of plastic, wax, or sometimes metals are made conductive by application of carbon or metallic powder and are plated by conventional methods. Nickel, copper, or precious metals are generally selected for this form of plating. The mold is generally removed at the completion of the plating process by one of a number of methods depending on the material from which the mold is constructed.

electrogalvanizing = Electrodeposition of zinc coatings.

electroless plating = The process of depositing metal from a water-based solution using chemical catalysts for the metal cation reduction process. In this process no external potential (electrical current) is applied.

electrolyte = A conducting medium in which the flow of current is accompanied by movement of matter;most often an aqueous solution of acids, bases, or salts, but includes many other media such as fused salts, ionized gases, and some solids.

electrolysis = Production of chemical changes by the passage of current through an electrolyte.

electrolytic etch = A technique generally applied to steels which attack the surface to produce a clean, oxide free

material. It is often used prior to electroplating, especially chromium plating. Since it preferentially attacks edges it will open us small cracks in the surface of the workpiece. Due to this, this process can be used to inspect finishes for flaws.

electrolytic polishing = An electrochemical process usually applied to steels, aluminum, and aluminum alloys. This process produces a surface that is bright and highly reflective. In most instances this is used for decorative purposes and is often used in conjunction with some other form of metal finishing such as anodizing, plating, or lacquering.

electroplating = The process of depositing metal from an aqueous solution using an external potential (electrical current) for the metal cation reduction process; usually, the potential applied is DC, but can approach controlled AC with some sophisticated switching devices (pulsed electroplating).

electro-osmosis = See "reverse osmosis"

electrorefining = The process of anodically dissolving a metal from an impure anode and depositing it cathodically in a purer form.

electrowinning = The production of metals by electrolysis with insoluble anodes in solutions derived from ores or other materials.

emulsion cleaning = A cleaning technique which acts by emulsifying contaminants. Emulsions are mixtures of two liquids, with one liquid holding the other in a suspension similar to colloidal suspension. The liquids will typically have different polarities and will dissolve different types of materials. One of the liquids is usually water and the other will have non-polar properties. They can therefore be used to dissolve non-polar contaminants like oil and grease from metal surfaces.

etching = Etching is sometimes used a surface preparation technique prior to electroplating or for removal of metal such as in the printed circuit industry where material not required on the finished product is removed by a chemical solution. It can also be used as an inspection technique due to its ability to accentuate surface cracks and defects.

"ferrostan" process = A method of continuous electrolytic tin plating of steel strip in which cold reduced strip is continuously fed through the cleaning, etching, plating, and rinsing processes. The solution is generally acid sulfate which produces a matte finish.

filtration = A means of separation where constituents are separated usually by physical methods.

fire gilt process = A process used exclusively in the jewelry trade in which gold dissolved in mercury (gold amalgam) is wiped on surfaces to be plated. When the article is heated the mercury is driven off leaving a gold film. The process represents a considerable health hazard due to the emission of the mercury vapor.

flocculation = The combination or aggregation of suspended colloidal particles in such a way that they form small clumps; usually used in conjunction with additive chemicals (flocculants) to treat wastewater.

fluxing = A process used in the heating of metals which may be intended to reduce or eliminate oxidation, confine the products of oxidation, reduce their melting point, and improve fluidity of surface metal layers. Fluxing is generally used in casting, welding, and soldering.

foam blanket = An additive that forms a layer on the surface of electroplating baths that have poor anode/cathode efficiency, to prevent any mist or spray from escaping.

fouling = Deposition of materials on a membrane surface or within the pores because of soluablility limits (at the surface) or pore size and/or shape.

free cyanide = (1) *Calculated* - the concentration of cyanide or alkali cyanide present in solution in excess of that calculated as necessary to form a specified complex ion with a metal or metals present in solution. (2) *Analytical* - the free cyanide content of a solution as determined by a specified analytical method.

frosting = A type of metal finishing where a fine matte finish is produced by using techniques such as acid-etching, blasting, scratch brushing or barreling.

galvanic cell = An electrolytic cell capable of producing electrical energy by electrochemical action.

galvanic protection = A general term used in the corrosion protection of steel. Technically, it refers to a metal used to protect a metal higher than itself in electrode potential. In practice, it refers to the use of zinc to protect steel.

galvanizing = A corrosion protection technique applied only to mild steel, cast iron, and steel alloys in which workpieces are immersed in liquid zinc at 500 degrees Celsius. A zinc/iron alloy is formed at the surface of the workpiece giving it an adherent coating of zinc. Prior to galvanizing, the metal surface must be in a state of moderate cleanliness. This is generally accomplished by light acid pickling or blasting. Galvanized coatings are generally about 0.005 inches thick and can give protection for 10 to 20 years.

gilding = A process in which gold is coated on the surface of another base metal. Gold leaf, a layer beaten so thin it is porous to light, is glued or beaten onto the article to be gilded. A similar method applies a fine gold powder mixed with a flammable liquid solvent applied to the article like a paint. The solvent is allowed to evaporate or in some cases may be ignited.

gold plating = gold has two specific properties which make it valuable in industrial and commercial uses, it resists oxidation and corrosion to a very high degree and it retains its attractive color. The main advantage of gold plating over other methods of applying gold to surfaces, is that electroplated coatings do not have pores as gilded coatings do. This provides significantly longer lifespans and corrosion resistance.

grit blasting = A technique of abrasive cleaning or surface preparation using sharp particles (e.g., cast iron shot, aluminum oxide). It covers such processes as removal of scale, corrosion, paint and other surface films. Use of free silica presents a health threat and should be avoided.

hard chromium = Chromium plate for engineering rather than decorative applications; not necessarily harder than the latter, but generally thicker or heavier. See "chromium plating".

hard facing = A term referring to processes used to harden metal surfaces and impart wear resistance by a variety of heat treatments. See "metal spraying".

HCD (High Current Density) = High amperes per surface area.

hot dip coating = See "galvanizing".

hydrogen embrittlement = A defect which occurs during the electroplating process. Atomic hydrogen is produced at the cathode of the workpiece being plated. This atomic hydrogen is extremely reactive and has the capability of entering the interstices of the metal. Being unstable in the atomic state, the hydrogen will combine as rapidly as possible with other atoms to form molecular hydrogen. This molecular hydrogen, having a higher unit volume than atomic hydrogen results in internal pressure in the plated metal.

immersion plating = A plating technique similar to electroless plating where a more electropositive metal is dissolved in an electrolyte and is plated onto the surface of a less electronegative metal workpiece. The term immersion plating is used where a deposit is obtained and the plating process then stops. This is distinguished from electroless plating where the deposition of the metal being plated continues to deposit as long as the workpiece remains in the solution.

inchrom process = see "Chromizing".

indicator (pH) = A substance that changes color when the pH of the medium is changed; in the case of most useful indicators, the pH range within which the color changes is narrow.

indium plating = Indium is a metal not unlike lead but with friction and corrosion resistance properties that are